

Public perception of energy transition in Korea: Nuclear power, climate change, and party preference

Ji-Bum Chung^a, Eun-Sung Kim^{b,*}

^a School of Urban and Environmental Engineering, Ulsan National Institute of Science and Technology (UNIST), UNIST-gil 50, Ulsan 689-798, Republic of Korea

^b Department of Sociology, Kyung Hee University, 26 Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Republic of Korea

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ABSTRACT

Since President Moon Jae-in took office in May 2017, South Korea has been embroiled in a major social controversy about energy transition. The president's pledge to transition toward renewable energy represented a dramatic change in Korean energy policy, which has been focused on nuclear and coal-fired plant expansion policies since the 1970s. This study examines public perception of energy, with focus on the relationship between nuclear power and climate change as well as party preferences, based on a nationally representative survey of Korea. The survey data shows that the risk-risk tradeoff strategy, reframing nuclear power generation as a way to mitigate the risks of climate change, seems to be ineffective in Korea. Furthermore, nuclear power represents the values of the elderly, materialists, developmentalists, and conservative political parties. These results suggest that Korean energy policy is a very political issue rather than a strictly scientific or economic one. Therefore, this issue should be deliberated through a democratic process.

1. Introduction

Since the 1960s, South Korea has achieved rapid economic development called “compressed development.” The Korean government has sought to secure energy resources that can be supplied inexpensively and consistently to maintain rapid economic growth. As a result, electric power production, primarily in the form of coal and nuclear power, soared from about 1.8 TWh in 1961 to 433 TWh in 2015 (Korea Electric Power Corporation, 2016). Currently, coal accounts for the largest portion of electricity generation in Korea (39.1%), followed by nuclear power (30%) and Liquefied Natural Gas (LNG) (21.4%) (Korea Electric Power Corporation, 2016). South Korea, located in the Korean Peninsula, cannot connect to the Eurasian continent because of military confrontation with North Korea. Therefore, after the Korean War in 1950, all power has been produced domestically, and a stable supply of electric power has been the most important policy priority above any other concerns. All energy resources needed in Korea are imported from overseas, and nuclear power has played a critical role in Korean energy security. Although nuclear fuel has also been imported from overseas, its long fuel cycle and long-term contract of import (more than 20 years) contribute significantly to energy security in Korea. As of December 2016, 25 nuclear power plants are operating in Korea, ranking sixth in the world by number and is the greatest in terms of number of nuclear power plants per unit land area (IAEA, 2017). The share of

nuclear electricity production was 30.3%, at number 13 in global rankings (IAEA, 2017).

As the risk of climate change has deepened, shifting to a low-carbon economy has been emphasized internationally. Transitioning to a low-carbon economy implies entry into the new climate regime. The global community recognizes the seriousness of climate change and strives to mitigate risks through the Kyoto Protocol established in 1997 and the Paris Agreement of 2015. Korea also aims to reduce greenhouse gas (GHG) emissions by 37% by business as usual standards by 2030 (UNFCCC, 2016). The Korean public also wants low-carbon development. The expansion of coal-fired power plants and rapid increase in automobiles have worsened the problem of fine dust in Korea. After the impeachment of President Park Geun-Hye in 2017, resolution of the problem of fine dust became one of the most important issues in the Korean presidential election. However, nuclear power has caused serious social conflict surrounding the issue of spent fuel and radioactive waste disposal. In Anmyeon Island (1990), Gulpul Island (1994), and Buan City (2003), opposition to the radioactive waste repository has developed into violent demonstrations. Thus, since the 1990s, the Korean government's energy management policy has not successfully satisfied the changing needs of the people. Public acceptance has increasingly become an important factor in the choice of energy source.

The purpose of this study is to examine the following research issues. First, we identified which future energy sources Koreans think are

* Corresponding author.

E-mail addresses: learning@unist.ac.kr, chung.jibum@gmail.com (J.-B. Chung), eskim711@khu.ac.kr (E.-S. Kim).

preferable. Secondly, we analyzed the relationship between the perception of favorable energy sources and the perception of climate change. Thirdly, we analyzed factors affecting Korean preferences for various energy sources. Among them, demographic factors, values, political tendencies, and awareness of climate change were examined. In this process, public acceptance of recent controversial “risk-risk tradeoffs” of climate change and nuclear power has been identified (Bickerstaff et al., 2008). The fact that nuclear power plants produce very little GHG emissions has been useful rhetoric to pro-nuclear energy groups for increasing the number of nuclear power plants in Korea.

This paper is presented in the following order. First, we examine the research that has dealt with public perception of energy sources. This literature review reveals which factors influence energy preferences. We also examine risk-risk tradeoff debates concerning climate change and nuclear power. Secondly, we present the survey method used in this study to investigate the public perception of energy sources. Thirdly, the results of the survey analysis are presented. Finally, the implications of the study are discussed.

2. Background and literature review

2.1. Public perceptions on future energy

In the determining the energy mix of a country, various points of view must be considered. Globally, important issues in energy system transformation include energy security, affordability (low costs), climate change mitigation, and environmental protection (European Commission, 2002, 2007; Parkhill et al., 2013). According to a UK survey in 2012 (Parkhill et al., 2013) for the UK public, affordability (keeping energy bills affordable) was viewed as the most important policy priority (40%), followed by energy security (making sure the UK has enough energy) (32%). Climate change was also rated important (27%); however, this issue was viewed as less significant than affordability and security. A Eurobarometer survey (European Commission, 2002, 2007) showed similar results.

Various surveys have been conducted asking about the energy preferences of the public or suitable future energy sources. Taken together, we can easily identify that renewable energy has been selected as the most preferred energy source in many cases. Many survey results (European Commission, 2002, 2007; Karlström and Ryghaug, 2014; Parkhill et al., 2013; Pidgeon et al., 2008; Poortinga et al., 2013; KNEA, 2015) showed that the public is most likely to prefer renewable energy sources such as solar, wind, and hydroelectricity to fossil fuel energy and nuclear power. Furthermore, in response to a question asking about future energy sources in 30 years (European Commission, 2007), the greatest expectations were for renewable energy. In Korea, the result of the national survey question “what is the energy to be used most in the future” asked by the Korea Nuclear Energy Agency (KNEA, 2015) was also renewable energy (58.1%). However, in some cases, nuclear power was recognized as an important future energy source based on recognition of it as ‘a necessary evil’ (European Commission, 2007, p. 52).

Nevertheless, concerns about energy security persist for renewable energy, including ensuring a stable supply and affordability. Nuclear power may be sufficiently competitive in terms of security and affordability, but safety problems exist, including the risk of accidents that can develop into catastrophes. In particular, after the Fukushima nuclear power plant accident in Japan in 2011, the issue of safety became more prominent among members of the public. In terms of climate change and environmental protection, nuclear power has two sides. It generates very little GHG emissions but produces spent fuel that is environmentally harmful for very long periods of time.

2.2. Socio-demographic variables and energy support

There are several important socio-demographic variables that may influence support of or opposition to energy sources. Some of these

factors include gender, age, education (scientific knowledge), and marital status (Chung and Kim, 2009; Chung et al., 2008; Karlström and Ryghaug, 2014). Studies have mainly focused on energy-related NIMBY (Not In My Back Yard) or LULU (Locally Unwanted Land Use) issues. In particular, nuclear power has been a major research topic.

In terms of the influence of gender and energy preferences, women are more environmentally oriented than men (Karlström and Ryghaug, 2014) and have higher levels of risk perception regarding potentially dangerous energy technologies such as nuclear power (Chung and Kim, 2009; Chung et al., 2008). As indicated by the results of a recent survey in the United States (Pew Research Center, 2015), a majority of men (54%) favor building more nuclear power plants, whereas only 36% of women favor doing so. This trend is fairly consistent in other studies as well. Education or the level of knowledge about specific energy sources may generally increase public acceptance. In a questionnaire about building more nuclear power plants in the United States, half of those with a college degree or higher favored building more plants. In comparison, only 42% of those with a high school degree or less favored building more nuclear power plants (Pew Research Center, 2015). One survey conducted in China also demonstrated that people with university degrees or above have more positive attitudes regarding nuclear energy than people with less education (Yu et al., 2012).

Although age may be a very important factor for determining support for different types of energy, several studies have given an unclear picture of these relationships. A survey of German- and French-speaking regions of Switzerland demonstrated that age was negatively correlated with nuclear power plant acceptance (Siegrist et al., 2014). This finding indicates that older people were less likely to accept nuclear power compared with younger people. However, a recent survey in the United States showed different results. The result reported by the Pew Research Center (2015) demonstrated that older adults (ages 65 and older) were more inclined to favor building more nuclear power plants than were younger age cohorts. For the alternative energy sources such as wind and solar power, adults under 30 prioritized alternative energy development over fossil fuels by a 74% (alternative energy) to 20% (fossil fuels) margin. In contrast, for those aged 65 and older, the difference was only 7% (Pew Research Center, 2015). A study of the Australian public showed that support for renewable energy is stronger among younger Australians (Tranter, 2011). Likewise, a survey of the Norwegian public demonstrated that older people were generally more skeptical of renewable energy sources, such as onshore and offshore wind, than were younger people, and more favorable toward gas (Karlström and Ryghaug, 2014).

2.3. Risk-risk tradeoffs between climate change and nuclear power

Under the new climate change regime, the energy sources we choose in the future should be environmentally friendly without generating GHGs. Possible alternatives to fossil fuels are renewables and nuclear power. Nuclear power generation was once a dream technology thought to be able to solve human energy problems. However, the Three Mile Island accident in 1979 and the Chernobyl disaster in 1986 showed that nuclear power could pose a major threat to humanity. Since then, most Western countries, such as the United States and the United Kingdom, have not been able to build new nuclear power plants. However, as the price of energy surged and as the risk of climate change increased in the 2000s, the perception of nuclear power has begun to change. In fact, as international climate change negotiations progressed, the role of nuclear power was continuously discussed as a solution for the reduction of GHG emissions (Marshall, 2005). The use of nuclear power has been emphasized as a reliable alternative to solve the energy demand issues arising from the restriction of fossil fuels in response to climate change risks.

However, prominent environmental activists have claimed that this trend is the result of a clever public relations campaign by the nuclear industry (Marshall, 2005). Bickerstaff et al. (2008) argued that the use

of nuclear energy to combat climate change is a risk-risk tradeoff, replacing the risks of climate change with nuclear power, and evaluated it as a reframing strategy (Pidgeon et al., 2008). In other words, building new nuclear power plants to reduce GHG emissions is a tradeoff that replaces climate change risk with risk from nuclear power plants and radioactive wastes. However, the strategy of utilizing nuclear power to mitigate climate change has been actively employed in the nuclear industries of certain countries, including in Korea.

Did this strategy have a positive impact on public acceptance? Some studies have shown considerable effectiveness, but the impact seems to have been limited, especially after the Fukushima nuclear power plant disaster. According to an analysis of the reframing effect in the United Kingdom, the British public felt that climate change and nuclear power were both dangerous, and ‘reluctantly accepted’ that they should build nuclear power plants as an alternative to climate change (Pidgeon et al., 2008). In contrast, in the case of Japan, the general public was very negative toward nuclear power and did not agree with establishing nuclear power plants to mitigate climate change. According to survey results from Japan in 2011, after the Fukushima accident, agreement with the statement “I am willing to accept the building of new nuclear power stations if it would help to tackle climate change” was just over 20% (Poortinga et al., 2013). This acceptance rate was considerably lower than the result for Britain, which was over 50% (Poortinga et al., 2013).

Korea Hydro & Nuclear Power Co., Ltd. (KHNP) and the Korea Nuclear Energy Agency (KNEA), KHNP's exclusive public relation agency, have actively promoted nuclear power as a way to solve global warming. They have invested considerable amounts of money in a wide range of media promotion activities, including television commercials. However, the results do not seem positive. According to the results of a survey conducted by the KNEA in 2015, only 41.4% of respondents said that nuclear power contributes to “solving the climate change problem”, but 54.2% said that nuclear power could not contribute (KNEA, 2015). These results mean that nuclear power plants have not been recognized by the Korean public as an alternative power source for GHG reduction in Korea. In other words, reframing of nuclear power generation and mitigating the risks of climate change seemed to have been ineffective in Korea.

2.4. Political party preference and energy acceptance

“Value predispositions and ideology are often used as heuristics in decision-making” (Yeo et al., 2014, p. 729). Values can be the simplest heuristics of personal choice in complex modern societies. Stern (2000) pointed out that environmentally friendly human behavior is directly influenced by individual norms, which are in turn influenced by beliefs about the relationships between individuals and the environment. Beliefs are ultimately influenced by the relatively stable values of each individual (Stern, 2000). Stern named this framework the value-belief-norm (VBN) model, and many scholars have modified this model to explain human behavior regarding environmental issues. Whitfield et al. (2009) employed the VBN model to explain public perception of nuclear power and suggested that people use more intuitive and simple methods, rather than a sophisticated and logical calculations of the costs and benefits, when they are concerned about the nuclear problem, and that these methods are based mainly on the beliefs and values of each individual.

Generally speaking, values are a person's principles or standards of behavior. Values tend to reflect the demands of the times when individuals reach adulthood and last for a long time with little change after that (Inglehart, 1981). In this study, we used the Inglehart's indicator of post-materialism as a tool to explore individual values. According to Inglehart (1981), environmental behavior, especially regarding nuclear power, is distinguished according to different values. Nuclear power is recognized as an energy source representing the values of materialists, such as economic growth and strong defense forces.

Therefore, in almost every country, materialists prefer nuclear power, whereas post-materialists have a strong sense of rejection.

However, in modern societies, individual values are often expressed as political ideologies. Therefore, “political ideology provides a shared belief and value system through which people view and react to the world around them” (Gromet et al., 2013, p. 9314). Political ideologies are most easily distinguished according to which political party individuals prefer. Indeed, several studies have shown that attitudes toward nuclear power or eco-friendly behavior differ greatly depending on which party is preferred.

According to Pampel (2011), Europeans with rightist political views are more favorable toward nuclear power than are people with leftist political views. Gallup has consistently tracked Americans' preference regarding nuclear power, and in each survey, Republicans were more likely to favor nuclear energy than Democrats or independents (Rifkin, 2016). This tendency remained the same after the Fukushima accident, with supporters of the Republican Party retaining a higher preference for nuclear power than supporters of the Democratic Party. According to 2011 Pew Research survey results from just after the Fukushima accident, 39% of respondents said they favored promoting the increased use of nuclear power, whereas 52% were opposed. These figures represent a dramatic change from before the accident. In results from October 2010, 47% favored promoting the increased use of nuclear power, and an equal percentage (47%) were opposed (Pew Research Center, 2011). However, Republicans still favored expanding the use of nuclear power more strongly (49%) than independents (41%) or Democrats (31%) (Pew Research Center, 2011). Similar results were found for climate change. Politically, individuals who identified as closer to the political right have been found to be less concerned about climate change than those on the left and prefer to argue that the free market economy should be revitalized by reducing environmental regulations (Gromet et al., 2013).

These findings have significant implications. Instead of making complex technical and economic judgments about climate change and nuclear power, the public seems to utilize heuristics based on the values associated with individuals' political tendencies. This tendency is similar with respect to other advanced scientific fields. For example, political conservatives are typically less supportive of nanotechnology, stem cell research, and agricultural biotechnology (Yeo et al., 2014). Karlström and Ryghaug (2014) found that political party preference is an important factor informing citizens' views on energy questions. They examined several factors affecting public attitudes toward renewable energy technologies and demonstrated that party preferences are the most important factors. The results showed that left-wing parties are generally more environmentally oriented than others (Karlström and Ryghaug, 2014).

However, these energy preferences and political preferences cannot be interpreted as evidence of a causal relationship. Causality relies on the assumption that the public fully understands the energy policy of particular parties, and this assumption has not been verified. Therefore, it is desirable to understand the relationship between political preferences and energy preferences in terms of homology rather than causality. In other words, a person's political ideology is similar to his or her values regarding technology. For example, supporters of conservative parties tend to have values of economic developmentalism, which emphasizes the economic development of individuals and societies. They also value technological developmentalism and thus view science and technology as tools for economic growth (Kim, 2016, 2018). Therefore, supporters of conservative parties may prefer technology that can contribute to economic development regardless of its environmental and social value, whether that technology is nuclear or renewable.

3. Methodology and result

3.1. Methods

We conducted an online survey of a nationally representative sample of 1100 Koreans ages 14 and older from April 12 to April 24, 2017, during the 19th Korean presidential campaign period. The 19th Korean presidential election was held on May 9, 2017, after the impeachment of former president Park Geun-Hye. The main contents of the survey are demographic information such as gender, age, education level; post-materialist values; awareness of the severity of climate change; preference for various energy sources; preferred energy sources after 30 years; the costs and benefits of nuclear power plants; and opinions on the additional construction and shut down of nuclear power plants. We then compared our results with similar foreign surveys, such as the Eurobarometer, and evaluated the situation in Korea in the international context.

3.2. Public perceptions of climate change

Koreans take climate change issues very seriously. For the question “how serious a problem do you think climate change is at this moment?”, the average response was 8.24 (on a 10-point Likert scale, with ‘1’ meaning “not at all a serious problem” and ‘10’ meaning “an extremely serious problem”). This question was the same as that of the Eurobarometer (European Commission, 2015), for which the result was only 7.3 for the European public. This higher rating of the seriousness of climate change among the Korean public may be attributed to recent severe fine dust problems. In Korea, concerns regarding health issues caused by fine dust, including ultrafine and yellow dust, have rapidly grown since the winter of 2013 (Kang and Kim, 2014). The survey also showed a high level of concern for this fine dust problem. For the question “How serious a problem do you think fine dust is at this moment?”, the average response of the Korean public was 8.71.

Indeed, Korea's fine dust problem is very serious. According to the Health Effects Institute's (HEI) recent report, among the 35 OECD member countries, only Turkey has a worse level of dust pollution than Korea (Health Effects Institute, 2017). The cause of this fine dust is the use of fossil fuels, such as in coal-fired power plants, the same as the primary cause of climate change. The problem of fine dust can be interpreted as a problem of global climate change localized in Korea, caused by the sources of fossil fuels.

The Korean public was well aware that climate change was caused by fossil fuels. For the question “The use of fossil fuels (coal, oil, gas, etc.) contributes significantly to global warming and climate change”, 84% of the Korean public agreed. What was unusual is that many Koreans responded that nuclear power generation also exacerbates climate change and global warming. For the question “Nuclear power contributes significantly to global warming and climate change”, 43% agreed, 34% disagreed, and 24% said they did not know. Like the previously mentioned results of the KNEA survey, it seems that Koreans, in general, do not think that nuclear power generation is a solution to climate change problems. Rather, they view nuclear power as an environmentally harmful energy source that aggravates climate change.

In contrast to the perception of the Korean public, nuclear power produces very low levels of CO₂ emission. According to the IPCC (Schlömer et al., 2014), the lifecycle CO₂ emissions of nuclear power is only 12 gCO₂eq/kWh (median level), significantly lower than coal. Table 1 shows the lifecycle emissions of selected electricity supply technologies.

3.3. Preferable energy sources and future energy

Survey participants responded about their preferences for various energy sources (5-point Likert scale, with ‘1’ meaning “very unfavorable” and ‘5’ meaning “very favorable”). According to the results, the

Table 1

Lifecycle CO₂ emissions of selected electricity supply technologies (gCO₂eq/kWh). Source: Schlömer et al., 2014 (p. 1335).

	Lifecycle emissions (incl. albedo effect) Min/Median/Max
Coal	740/820/910
Gas	740/820/910
Biomass (cofiring)	620/740/890
Hydropower	1.0/24/2200
Nuclear	3.7/12/110
Solar Power (Concentrated)	8.8/27/63
Solar Power (Photovoltaic, utility)	18/48/180
Wind Power (Onshore)	7.0/11/56

Korean public, like those of other countries surveyed (European Commission, 2002, 2007; Karlström and Ryghaug, 2014; Parkhill et al., 2013; Pidgeon et al., 2008; Poortinga et al., 2013), preferred renewable energy sources. Although they reported a strong preference for environmentally friendly energy sources such as solar, wind, tidal, and water power, their preferences for fossil fuels such as coal and oil and for nuclear power were low. In particular, the preference for coal was the lowest (2.48), which can be attributed to concern about the risks of fine dust pollution. Nuclear power generation also had a low preference (2.71), but it was rated higher than coal or oil. These results are very similar to those of other countries, including recent surveys in the United Kingdom (Parkhill et al., 2013). Fig. 1 shows favorability toward energy sources for electricity generation in Korea.

In addition, we asked the Korean public's opinions on future energy sources. For the question, “thinking about energy in 30 years, which do you think will be the three most used energy sources in Korea? (MAX. 3 ANSWERS)”, which is the same as a question in the Eurobarometer survey (European Commission, 2007), the Korean public predicted that solar power would be the most used energy source (67.6%). Interestingly, the Korean public also perceived nuclear power as a very important future energy source (53%). Although the current preference for nuclear power is low, the Korean public has high expectations for nuclear power as a future energy source utilizing advanced technology. In contrast, expectations for wind energy, which is widely used in Europe, were low (30.6%). Fossil fuels traditionally used heavily in Korea were not considered suitable as future energy sources. Fig. 2 shows the Korean public's perception of which three energy sources will be used most in 30 years in Korea.

The Korean public's perception of energy policy priorities and importance were also investigated. For this issue, we used the question “In your opinion, which two of the following should be given top priority in the Korean government's energy policy? (MAX. 2 ANSWERS)” (European Commission, 2007). The answer choices were as follows: ① low price, ② continuous supply (preventing blackouts and fuel shortages), ③ environmental protection, ④ safety (protecting public health), ⑤ climate change mitigation, ⑥ energy independence (independent from energy imports from foreign countries), ⑦ energy saving, and ⑧ maintaining industrial competitiveness. For this question, the Korean public responded that guaranteeing a continuous supply of

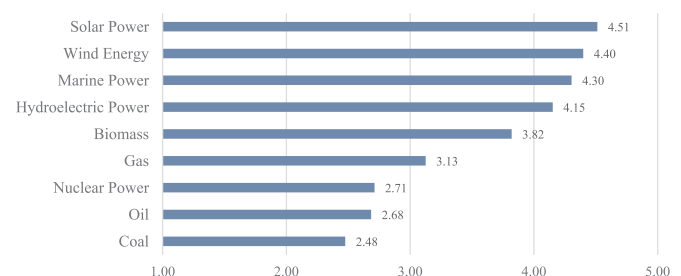


Fig. 1. Favorability toward energy sources for electricity generation.

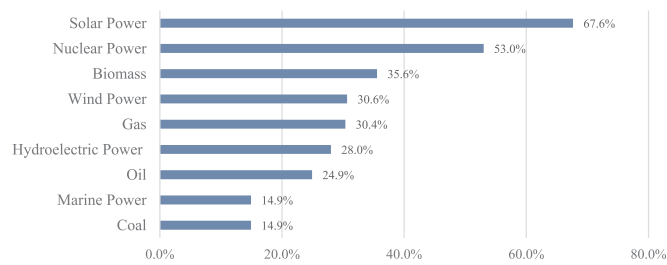


Fig. 2. Three most used energy sources in 30 years in Korea (all three answers added).

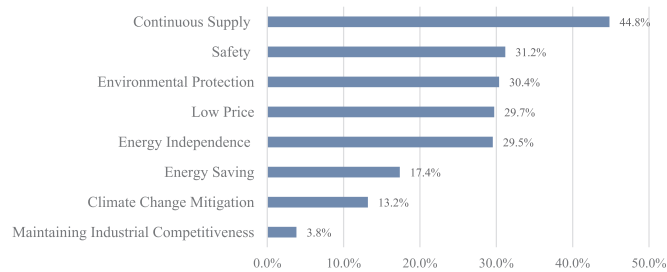


Fig. 3. Top Korean energy policy priorities and importance (both answers added).

energy (energy security) should be the top priority of Korean national energy policy. Fig. 3 shows the Korean public's perceptions of the top priorities for Korean energy policy.

These results are quite different from the results of similar surveys conducted in Europe. In case of 2007 European survey results (European Commission, 2007), the European public responded that guaranteeing low prices for consumers should be the top priority. The 2012 UK survey results (Parkhill et al., 2013) also indicated that the British public thought that low prices (keeping energy bills affordable for ordinary households) were the most important policy issue in the UK energy sector. South Korea is located on a peninsula, but it is like an island disconnected from the continent because of military confrontation with North Korea. In the UK, electricity can be imported from and exported to the European continent through submarine cables. However, Korea cannot import electricity from overseas because it has no power grid connections with neighboring countries such as Japan, China, or Russia. Furthermore, because of the blackout that occurred in Seoul on September 15, 2011, the Korean public view a stable supply of electricity is essential. In addition, they perceived safety (protecting public health) as the second most important factor, which was likely because of the Fukushima accident that occurred in neighboring Japan. After the Fukushima accident, the 2016 movie *Pandora*, with a fictional nuclear power plant accident in South Korea, became very popular. In the 19th presidential election in 2017, a nuclear-free policy was regarded as one of the most important presidential pledges.

3.4. Perceptions of nuclear power

In May 2017, Moon Jae-in, who pledged to decrease nuclear power plants in Korea, was elected as the 19th President of the Republic of Korea. After his inauguration, President Moon suspended the construction of units 5 and 6 of the Shin-Kori nuclear power plant, which had already been under construction. Subsequently, controversy over nuclear policy has intensified in Korea. Nuclear power is an important energy source for enhancing Korea's energy security, and as a future energy source utilizing advanced technology. However, there is significant concern about safety, as South Korea has the highest density of nuclear power plants in the world, with 25 nuclear power plants over the country's relatively small land area. The Korean Peninsula was previously believed to be very safe from earthquakes. However, an earthquake of Richter magnitude 5.9 occurred in September 2016 in Gyeongju, where six nuclear power plants are located, which heightened public anxiety. Although there were almost no physical impacts to the nuclear power from the earthquake, the psychological impacts on the Korean public were relatively large because the Gyeongju earthquake was the first earthquake felt by anyone in Korea.

In response to a question on building additional nuclear power plants or shutting down existing plants, the Korean public preferred immediate shutdown (10.9%) or long-term shutdown (46.3%) to the status quo (28.4%) or building new power plants (7.5%). To compare the attitudes of the Korean public on nuclear power with those of people in other countries, we used the same survey question as Poortinga and colleagues (2013). Their research compared the attitudes of the public toward nuclear power in Japan and Britain after the Fukushima accident. We attempted a meta-comparison of the attitudes of Korean public with the results of this previous study. The British and Japanese surveys used data from 2005, 2010 and 2011 for nationally representative samples. All data for 2011 were collected after the Fukushima accident. The survey in Japan was conducted in July 2011, and the British survey was conducted in August 2011 (Poortinga et al., 2013). The attitude of the Korean public toward nuclear power plants was in between those of the UK and Japan. Of course, there were differences in the timing of the survey and the items in the questionnaire. However, it was clear that the attitude of the Korean public toward nuclear power plants was more negative than that in the UK and more positive than that in Japan. Overall, the perception of nuclear power plants was negative for most items. Fig. 4 shows the attitude of the Korean public toward nuclear power plants compared to those of Japan and the UK.

The Korean public does not trust the Korean government's nuclear power plant regulations. Only 22% said that the government is managing nuclear power plants well. This result was higher than that in Japan after the Fukushima accident but lower than the result in the UK. However, direct comparison may be difficult because the result for

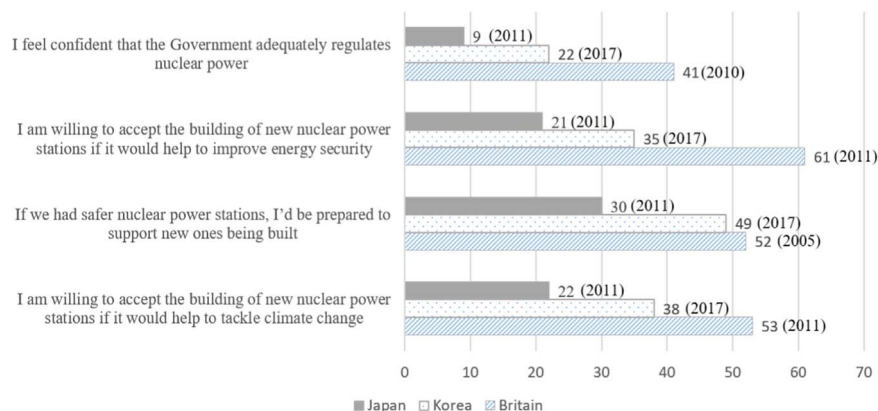


Fig. 4. Agreement with the series of statements in surveys of the Japanese, British, and Korean public.

Britain is based on a survey before the Fukushima accident (2010). Only 21% of Japanese respondents agreed with constructing a new nuclear power plant if it could help with energy security, but 61% of the British public agreed, even after the Fukushima accident. In contrast, only about 35% of the Korean public agreed with such construction, about half of the percentage in the UK. Similar results were found for support for building new, safer nuclear power plants. Agreement with this statement in Japan was only 30%, although this figure was higher in Korea, which was similar to the UK response. In particular, for the question about conditional support for nuclear power plants in the context of climate change, the Korean public showed negative responses; only 38% agreed. Similar results were found for Japan, with only 22% agreeing. In contrast, the British public agreed to a reframed argument of building nuclear power plants to prevent climate change (over 53%).

3.5. Values, recognition of the seriousness of climate change, and energy preference

To analyze the attitudes of the Korean public toward energy sources in depth, we examined the factors that affect preferences for each energy source. For this purpose, preferences for oil, nuclear power and solar energy were analyzed as representatives of fossil fuels, nuclear power, and renewable energy. Based on the theoretical implications presented above and relevant socio-demographic variables, we performed least squares regression analysis of the favorability of different energy sources with a series of relevant background variables, including recognition of the seriousness of climate change, party preference, and Inglehart's post-materialism index.

In this analysis, the independent variables were post-materialism index points (0–1: post-materialist, 2–4: mixed, 5–6: materialist; mean = 3.16; SD = 1.213), education level (1: no education, 2: elementary school, 3: middle school, 4: high school, 5: college or university, 6: graduate school; mean = 4.71; SD = .771), perception of the seriousness of climate change (1: not at all a serious problem, 10: an extremely serious problem; mean = 8.24; SD = 1.600), age (14–68; mean = 36.9; SD = 14.459), sex (male = 50.6%, female = 49.4%; changed to a dummy variable), and party preference (Liberty Korea Party = 5.6%, Democratic Party = 35.3%, People's Party = 22.2%, Bareun Party = 3.7%, Justice Party = 3.7%, others = 29.5%; changed to dummy variables). Among the political party in Korea, the Liberty Korea Party is the most politically conservative, the Justice Party is the most political progressive, and the other parties are in between these two. President Moon, elected in 2017, is a member of Democratic Party. Tables 2, 3 show the summary of the variables and Table 4 presents the regression coefficients for preferences for different energy sources.

First, in the case of post-materialist values, more materialistic respondents reported stronger preferences for all energy sources including oil, nuclear power, and solar. It seems that materialists favor any type of energy source because they all can help economic growth. In the survey results, 13.2% of respondents were materialists, 78.9% were mixed, and 7.9% were post-materialists. In Korea, the percentage of post-materialists is lower than in Western societies. In particular,

Table 2
Summary of ordinal variables in regression analysis.

	N	Min	Max	Average	S.D.
Favorability toward Oil	1074	1	5	2.48	1.012
Favorability toward Nuclear Power	1063	1	5	2.71	1.240
Favorability toward Solar Power	1075	1	5	4.51	.821
Post-materialism Index Points	1100	0	6	3.16	1.213
Perception of the Seriousness of Climate Change	1095	1	10	8.24	1.600
Education Level	1100	1	6	4.71	.771
Age	1100	14	68	36.90	14.459

Table 3
Summary of categorical variables in regression analysis.

		Frequency	Percentage
Sex	Male	557	50.6
	Female	543	49.4
Party Preference	Liberty Korea Party	62	5.6
	Democratic Party	388	35.3
	People's Party	244	22.2
	Bareun Party	41	3.7
	Justice Party	41	3.7
	Others (the other parties + No preference)	342	29.4

Table 4
Regression coefficients for preferences for different energy sources.

	Oil	Nuclear Power	Solar Power
Post-Materialist Value	.113***	.118***	.066*
Climate Change	-.151***	-.189***	.319***
Education	.029	.013	.023
Age	.004	.104**	.037
Sex	.058	-.128***	-.030
Liberty Korea Party	.006	.132***	-.032
Democratic Party	-.001	-.044	.053
People's Party	-.016	.045	.036
Bareun Party	.032	.019	-.062*
Justice Party	-.074	-.061*	.046
Adjusted R squared	.039	.119	.126

* Indicates significance between the .05 and .01 levels.

** Indicates significance between the .01 and .001 levels.

*** Indicates significance less than the .001 level.

since the mid-1990s, the trend toward post-materialism has declined because of the economic crisis and the spread of neoliberalism (Park and Kang, 2012). Post-materialism in Korea shows a distinct generational difference. The proportions of materialists by age group are: teenagers, 6.3%; 20 s, 9.5%; 30 s, 6.3%; 40 s, 17.1%; 50 s and older, 24.5%. Thus, higher ages are associated with greater materialism.

Older people preferred nuclear power. This finding is consistent with the fact that older people in Korea prefer materialistic values. However, there was no significant age-related relationship with solar and oil. Results for gender were similar to those of previous studies. There were no significant differences for oil or solar energy, but nuclear power was preferred significantly more by men than by women. The reason for this trend seems to be that the risk perception level of women is higher than that of men, as was repeatedly found in several previous studies.

Among all variables considered, the recognition of the seriousness of climate change was the most important variable in determining each energy preference. The more the problem of climate change was recognized as serious, the stronger the preference for solar energy as a representative of renewable energy sources. This correlation was very statistically significant ($p < .001$). In contrast, the recognition of the seriousness of climate change decreased the preference for oil and nuclear power ($p < .001$). This result for oil is quite reasonable because burning oil is directly responsible for climate change and fine dust pollution, but the similar result for nuclear power seems unreasonable. Although internationally nuclear power is recognized as a major energy source for mitigating climate change, the Korean public did not think so. Rather, the more climate change was recognized as a serious problem, the stronger the rejection of nuclear energy. This attitude toward nuclear power seems to be heavily dependent on the political position of each individual.

Political party preference has a statistically significant effect on preference for nuclear power. The most politically conservative people, those who prefer the Liberty Korea Party, had a stronger preference for nuclear power. In contrast, the most politically progressive (as well as

the most environmentally friendly) people, those who prefer the Justice Party, showed the lowest preference for nuclear power. These results make it possible to infer that the attitudes of the Korean public toward nuclear energy are greatly influenced by individual political characteristics. Nuclear power is an energy source with a very low carbon output, but a larger proportion of people in Korea believe that nuclear power is contributing to climate change (43% vs 34%). Although several studies have shown that education level and knowledge increased the acceptance of nuclear energy, the results of this analysis showed no statistically significant correlation with education.

As a result, it is apparent that the Korean public's attitude toward nuclear power is greatly influenced by their political positions and environmental attitudes rather than by actual knowledge about nuclear power. These results show that the public judges climate change and nuclear power through heuristics based on their political tendencies instead of making complex technical and economic decisions. In other words, conservative Liberty Korea Party supporters are likely to follow the values of materialism and make decisions favorable of nuclear power based on their political position. In contrast, people with environmentally friendly (or politically progressive) values prefer renewable energies to both fossil fuels and nuclear power. Although nuclear power has little effect on climate change, it is recognized as an environmentally harmful source of energy. Therefore, eco-friendly people who are concerned about climate change seem to be making judgments about nuclear power using their environmentally friendly heuristics, rather than seriously considering the relationship between nuclear power and climate change.

4. Conclusions and policy implications

Altogether, the rejection of fossil fuels by the Korean public was high in most groups, especially among post-materialists. Furthermore, the more people regard climate change as a serious problem, the lower their preference for fossil fuels. This trend is a reflection of the clear recognition that fossil fuels are exacerbating climate change. Moreover, in Korean society, fine dust pollution has become a severe social problem, and resistance to fossil fuels has become stronger. As a result, from the viewpoint of public acceptance, fossil fuels may not be suitable as future energy sources in Korean society.

There is a clear difference in the public recognition of nuclear power and renewable energy. This difference is closely related to the perception of the seriousness of climate change in particular. The more serious people consider climate change, the stronger their preferences for renewable energy sources such as solar power. However, preferences for nuclear power tend to be lowered. Of course, nuclear power can contribute to mitigating climate change because its GHG emissions are very low, but the Korean public seems to perceive nuclear energy as an environmentally hazardous energy like fossil fuels. In other words, most people with eco-friendly values are against nuclear power, whereas those with development-oriented values seem to have pro-nuclear attitudes. Rather than scientifically or economically analyzing nuclear power and climate change, people made judgments based on their political and environmental value heuristics. This means that there is a significant public misunderstanding about the link between climate change and nuclear power plants in Korea. Therefore, the Korean government needs to take efforts to educate the public on the risks and benefits of all energy options in an impartial manner.

However, it is not only an issue of knowledge but also of values. The analysis of the public energy perception from the viewpoint of post-materialism (Inglehart, 1981) and political party preference has significant implications. It seems that Korean politics have been constructed based on the value judgments of materialism. At present, Korean conservative parties have played a role in continuously reproducing the economic developmentalism pursued by the “developmental state” model of the Park Chung-hee administration in the 1970s (Amsden, 1989; Park, 2011; Kim, 2016, 2018). Economic

developmentalism means valuing creation of a wealthy nation through economic development. Park Chung-hee considered science and technology to be critical tools for economic growth and expanded “technological developmentalism” (Kim, 2018). The succeeding conservative governments of Lee Myung-bak and Park Geun-hye followed the developmental state model. Accordingly, conservative parties have understood science, technology, and energy as economic growth engines.

In Korea, nuclear power has the “sociotechnical imaginaries” of “atom for development” (Jasanoff and Kim, 2009) as an energy representing the values of the elderly, materialists, developmentalists, and political conservatives. However, this trend is not the case only in Korea. In Western societies such as the United States and Europe, conservatives (materialists) have an image of nuclear power as a symbol of economic growth and strong national defense (Inglehart, 1981), and supporters of conservative parties prefer nuclear power (Pampel, 2011; Pew Research Center, 2015). Because of the path dependence of the developmental state, Korea's energy policy over the past 50 years, based on the values of economic developmentalism, has behaved against democracy in policy decisions and implementation processes (Kim, 2016, 2017). In the processes of determining the energy mix and selecting power plant sites, the elite technocracies of the government and the energy industry led the entire decision-making process without the involvement of civic groups and residents. Therefore, Korean energy policy caused considerable social conflict with environmental groups and residents.

However, with the election of President Moon Jae-in in May 2017, Korean energy policy is undergoing a major transformation. President Moon's promise to shut down coal-fired power plants and nuclear power plants over the long term was an important milestone showing changes in national policy toward future energy sources. As a result, the government ordered the suspension of construction of units 5 and 6 of the Shin-Kori Nuclear Power Plant, in which more than \$1 billion USD had already been invested. This decision was a dramatic change in Korea, which has been pursuing nuclear expansion policies since the 1970s, and there has been fierce debate between pro-nuclear and anti-nuclear groups. Given the political nature of nuclear power, this debate can be recognized as a political and democratic issue, not simply a matter of science and economics. This is also true for other countries. As a result, countries around the world have used political solutions to decide national-level nuclear policy. For this purpose, they ask the public directly about nuclear issues, rather than relying on scientific and economic analyses. Indeed, Sweden (in 1980), Italy (in 1987), and Switzerland (in 1990) have used national referendums to determine support for decisions to maintain or shut down nuclear power plants. Surely, referendums cannot be final decisions, because changing public sentiments with changing circumstances can affect the decision again. For example, Sweden had its referendum in 1980, and based on the response the government decided to phase out nuclear power. However, in June 2010, Parliament voted to repeal this policy.

Choosing future energy sources through national referendums is appropriate in terms of democracy. However, there is a question of whether a national referendum is real democracy. True democracy can be realized through the values of political equality and deliberation (Fishkin and Luskin, 2005). Political equality means equal consideration of everyone's preferences. A referendum involving the entire population is a suitable method for the realization of political equality. However, a referendum cannot guarantee successful deliberation. Deliberation is a process of weighing competing considerations through discussion, and that discussion should be informed, balanced, conscientious, substantive, and comprehensive (Fishkin and Luskin, 2005).

Due to the continuing fierce controversy over the suspension of the construction of Shin-Kori units 5 and 6, the Moon Jae-in government proposed a deliberative poll on June 27, 2017. According to Luskin et al. (2002, p. 458), “Deliberative Poll is designed to show what the public would think about the issues, if it thought more earnestly and had more information about them.” The Shin-Kori deliberative poll

followed the formula proposed by Fishkin (Luskin et al., 2002). 1) A national probability sample of the citizen voting group was selected, (first sampling of 20,000 on Aug. 28, then 500 selected on Sep. 13) using double sampling for stratification among the first sample of 20,000. 2) Briefing materials were sent (Sep. 28) to help inform the sample group and get them thinking more seriously on the subject. 3) The sample group were transported to a single location, where they stayed three days discussing the issues within moderated small groups and a larger group with professional experts (Oct. 13). 4) The citizen voting group were questioned again on Oct. 15. The final vote was to “resume construction” (59.5%), which was 19.0% higher than to “stop construction.” However, for the opinion on future nuclear power plants policy, respondents preferred “decrease the share of nuclear power plants” (53.2%) to “maintain” (35.5%) or “expansion” (9.7%). Following these recommendations, the Korean government resumed the construction of Shin-Kori units 5 and 6, maintaining their position of decreasing nuclear power plants in the long run.

The deliberative poll on the suspension of the construction of Shin-Kori units 5 and 6 is of great significance as it is the first attempt in Korea to determine a future energy source through democratic procedures that can satisfy both political equality and deliberation. Despite its significance in Korean energy policy, experts pointed out a number of problems with this procedure. Above all, the Korean government and the public have not had enough experience with such a delicate democratic process. In addition, although it is necessary to conduct a discussion with sufficient time for a proper deliberative poll process, the whole process was planned for only three months. Furthermore, some experts pointed out problems of inappropriate topic selection and lack of legal grounds.

The determination of future energy sources is not simply a matter of science and economics. In particular, this statement is true for nuclear power. The choice of future energy sources is a very complex issue that must satisfy climate change problems, economic feasibility, energy security on the supply side, and the safety of people's lives and property. Among these issues, public acceptance is typically important for successful energy regime change. Therefore, this is a problem of democracy that requires strong public support based on sufficient deliberation.

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